AURA
Association of Universities for Research in Astronomy

Statement by

William S. Smith, Jr.
President, AURA

To

The HST-JWST Transition Review Panel

August 6, 2003

The HST-JWST Transition Review Panel will address one of the most important science policy questions of the decade. NASA is to be commended for its commitment to public dialogue and the high quality of the panel selections. This has been one of the hallmarks of NASA science for the past 20 years.

In calling for this review, the Congress has recognized that the manner in which Hubble Space Telescope operations are terminated will have implications far beyond programmatic or budgetary considerations, but will affect the very nature and direction of the astronomical community just as HST has affected it over the past ten years. Given this, it is of the utmost importance that the key decisions on how and when to terminate HST be fully transparent and that the community be directly involved.

In reviewing NASA's current plan, the basic charge to the panel is to examine the best scientific use of the unique capabilities of Hubble and to ensure that the plan incorporates flexibility for failures of instruments, limitations on shuttle servicing missions, and delays in the JWST program. This scope, while broader than the actual Congressional mandate, is appropriate given the major uncertainties introduced by the Columbia accident and by the evolving nature of JWST.

Comparing Scenario Costs

There are nearly a dozen plausible disposition scenarios of varying scientific merit, technological maturity, cost, and risk. There has been a great deal of public dialogue characterizing the relative costs of these options. It is important to establish some consistency and comparability so that the ultimate trades can be made in a rational way. In a de facto sense, these should be compared to the current NASA baseline, SM4 in 2004 followed by a Shuttle return mission in 2010, although it is reasonably certain that

neither of these will materialize in the way envisioned. Appendix I compares the major options in a general sense and the deltas from this baseline scenario.

In comparing these, it is important to distinguish cost from accounting. That is, NASA has implemented a full cost accounting standard in which all mission-associated costs are explicitly identified. These include the direct research related costs, service costs (printing, computing, etc.) and the personnel overhead costs both within Headquarters and the NASA Centers.

NASA has, at times, proposed a broader implementation of this principle that may include the transfer of funding from the Science account to the Space Flight account to pay for Shuttle consumables, hardware, and operations[1]. While Congress has not approved of such transfers in the past, it remains a future goal for NASA[2].

It is important to note that the Shuttle is funded on a flight rate basis, not a mission-by-mission basis. A Shuttle flight not used on HST is used for some other purpose, e.g. Space Station, and there is no funding freed up to be allocated to other science programs. Following the Challenger and Columbia accidents, the budget for Shuttle operations remained relatively unchanged even though no missions were taking place. Thus, although the opportunity costs of Shuttle are an important policy consideration, the most important discriminator of cost is that which must actually be **added** to the budget.

Shuttle mission budget items which constitute actual program funding requirements within the space science budget, are science related costs (e.g. instrument hardware and engineering ~$200 M per mission), mission unique hardware (e.g. Shuttle carriers~$30-40M in the past), and operations and engineering support (~$150M per mission). A Shuttle mission for a non-servicing purpose, such as attaching a propulsion module, would also require mission unique hardware and engineering support. These could be of about the same magnitude although they have not been characterized very well.

[1] At present, Shuttle missions are funded through a separate appropriation account and funds can only be spent through that account. This is the result of a widespread and strong consensus reached nearly two decades ago that a statutory wall should be placed between NASA science and human space activities such as Space Station and Space Shuttle. This was intended to provide stability for NASA science to insulate it from escalating budgets in those other areas. Four years ago, NASA sought from Congress a restructuring of the appropriations accounts to provide for a single account in which Shuttle costs could indeed be funded through mission lines like HST. As an alternative, NASA proposed "revolving funds" to allow a more facile transfer and management of these funds. Congress rejected both of these concepts, but did agree to eliminate accounts that were related to General and Administrative costs, i.e. salaries. Since 2002, NASA has requested, and received, a limited transfer authority between accounts for service pools and G&A related costs. However left untested is the principle of actually paying for Shuttle mission operations through such transfers.

[2] If such an accounting structure were to be put into effect, shuttle related budget items would be appropriated directly to the Space Science account rather than the Space Flight account, and then managed by the Office of Space Science. That is, the space science accounts would be increased and space flight accounts decreased by the costs of the shuttle mission.

If, under full cost accounting, the Office of Space Science were to budget for Shuttle marginal costs (G&A pools, etc.) this would add about $80 M to the assessed cost of a servicing mission. Again, however, this would be $80M allocated and appropriated to the science account which would otherwise reside in the space flight account. It is not, in the aggregate, be an addition to the budget.

For other non-Shuttle alternatives such as a robotic mission, procurement of an ELV or propulsion module also requires an addition to the budget. Again, these have not been well characterized.

The FY04 budget submission by NASA indicates that from FY04 to full completion of HST in 2012, including a 2010 return, $1.37 Billion is included in the budget (bringing the total investment in HST to $6.8B without inflation). For the FY04 to completion budget projection, this represents an increase of $142 Million over the comparable budget projection of last year[3]. The HST budget identifies $137 M to be spent between 2007 and 2010 uniquely for the planning and execution of the return mission.

This scenario evident in the figure shows a deferral of the "funding wedge" that was to have developed once HST engineering teams and servicing capability was eliminated. This is the key funding wedge which, rhetorically, was to be used for JWST. Inspection of the past several fiscal years shows a systematic push to the right of this funding wedge. Yet, NASA has been able to accommodate this without affecting JWST or any other mission priority. This illustrates that, although there is a powerful management rationale for linking HST and JWST, from a budgetary standpoint these have proceeded independently. Indeed Congress has, from time to time, explicitly expressed a counter view towards making this linkage in a budgetary sense (see appendix II)[4].

From the Congressional standpoint, it is important to clearly state the funding needed to be added to the budget as a result of a science optimized scenario. This was a powerful but understated rational in calling for the present review. It is conceivable, but not likely, that the delta costs for an optimized scenario would be taken in whole or in part from some other NASA program. The converse however is certainly not true—that selection of a sub-optimized scenario generates funding to be added to another NASA program[5].

---

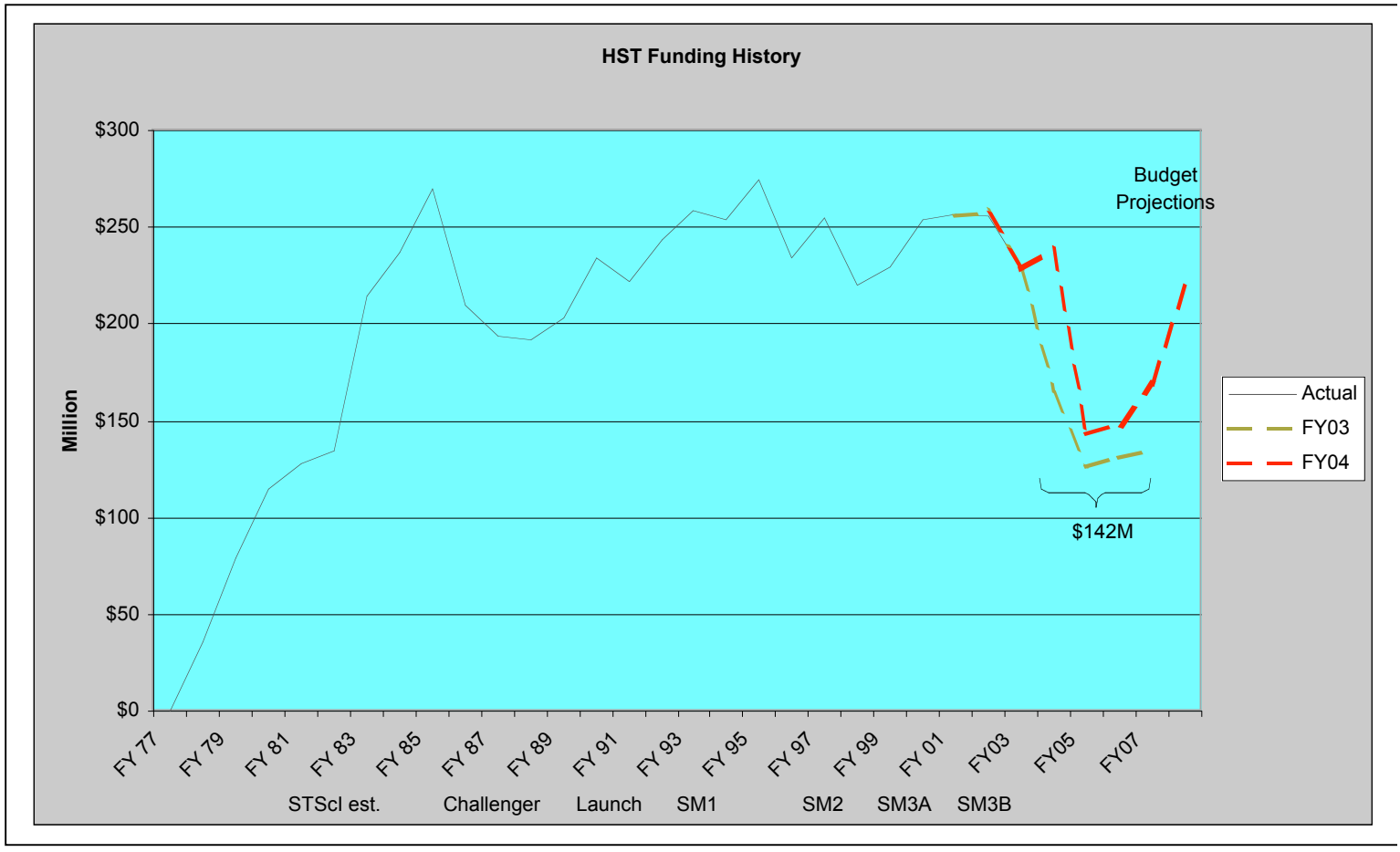
[3] Both of these assume that only the marginal costs of Shuttle are included in the Science budget, not the actual cost of the Shuttle operations budget.

[4] . In the FY03 Appropriations Conference report, the Conferees explicitly recognized that the Columbia accident may necessitate additional funding for HST. The expectation was that NASA would identify and request such funds.

[5] On the whole, it is not constructive to assume that HST termination scenarios will impact other missions, for example Midex missions, SUVO, JWST, Beyond Einstein, etc. Such comparisons do not have a clearly defined budgetary link and the opportunity costs are not transferrable.

It is most likely that HST termination scenarios will be considered and funded on their own merits just as other missions such as JWST, SUVO, Midex, Beyond Einstein, etc. will be funded on their own merits. This year, the increase in HST related out year budgets did not result from a decrease in JWST out year budgets or any of these other missions. In addition, the proposed Congressional reduction in FY 04 for JWST was not linked to any increase in HST. Both are viewed as high priority programs, yet they are viewed as independent programs. If a direct offset to accommodate a science optimized HST termination scenario were required, it would flow from a broader hierarchy of priorities, not as a trade between two high priorities.

As seen in appendix II, Congress has shown a consistent pattern of supporting or augmenting HST budget requests, although this can by no means be assumed for the future.



Judging Scientific Merit

Ultimately, the panel, as well as the broader community and NASA, will be faced with making key judgments regarding the anticipated potential scientific benefits of Hubble vs. the costs. In making these judgments, it is important to establish a common and consistent basis for assessing costs in a manner that ensures rational linkage of the potential outcomes. As stated, rather than judging Hubble costs and benefits relative to those of JWST, Midex missions, or other space science programs, the most rational comparison lies within the family of potential HST termination scenarios themselves.

A decision to undertake a science optimized termination plan for HST should be based on the inherent scientific merit itself. NASA and the community have a highly successful track record of identifying and advocating science priorities. Initiatives that have great merit, for example Beyond Einstein, have found their place in the overall hierarchy of priorities and are not the result of canceling or deferring other ongoing missions. The budget process is based on priorities for Federal spending overall which reaches far beyond the Origins program, the Physics and Astronomy division, or even NASA itself.

The scientific contributions of HST have been at the heart of some of the most sweeping changes in scientific thought and are directly linked to the highest priority objectives in the Decadal Survey and Quarks to Cosmos. HST has indeed enabled some of the more advanced questions and some of the future missions aimed at answering these questions.

The NASA Strategic Plan has emerged as a hallmark of community scientific planning. It includes a sequence of space science missions structured to provide an exciting, balanced, and intellectually logical succession of initiatives. AURA as well as the broader community has not only supported this plan, it has participated in its development at all levels.

An extension of the HST scientific mission should not adversely impact NASA's Space Science Strategic plan. Strong arguments can be made that the potential science benefits of an extended HST mission could support and augment many of the core objectives of the Strategic Plan. However, such an extension should not result in the delay or cancellation other planned missions for budgetary reasons.

Congressional and Public Interest

Clearly HST has achieved a nearly iconic status. From the outset, Congress has taken a special interest in HST. During its development phase, HST encountered a great many technical problems that increased its cost including design problems with orbital replacement latches, design problems with the fine guidance sensors, unusable Science Operations Ground System software, etc. Congress undertook special oversight activities and, most importantly, provided the additional funding needed to resolve these. During the period of prolonged storage after the Challenger accident, the costs of maintaining HST were perceived to be large, but again fully merited.

Following SM1 when HST became fully functional, this attention and support was rewarded. Since then, Congress has continued to pay special attention to HST during each budget cycle. Appendix II contains the actual actions and language in each appropriations bill since 1986. These comments illustrate both how the plan for HST has changed dramatically from year to year, and also that this has been a special matter of Congressional attention.

For the purposes of this review, the Conference Language contained in the FY03 Appropriations Bill should be viewed as a major factor. This language, contained in Appendix II, states the perceived value of Hubble and acknowledges the difficulty in planning for the end of mission in light of the Columbia accident. In particular, the language specifically acknowledges the need for additional funding and de-links the trade between HST and JWST. Clearly, there is an expectation that the work of the Transition Review panel will provide a major input for further scientific, management and budgetary decision-making both within and external to NASA.

APPENDIX I

HST Disposition Scenarios

Scenario	Cost Increases	Cost Decreases	Risk and Tech Maturity	Scientific Merit
Baseline: SM4, 2010 Shuttle Return	NA	NA	Likely to be deemed too risky for crew	Science ends in 2010
Uncontrolled reentry	NA	Saves two Shuttle missions, HST engineering support, instruments.	Greatly exceeds risk to ground	Science ends ~2007-9
ELV/remote prop module in lieu of SM4, Controlled reentry	Procure ELV, develop prop module, docking technology	Saves two Shuttle missions, HST engineering support, instruments.	Docking technology not mature	Science ends ~ 2007-9
Shuttle installation of prop module in lieu of SM4, Controlled reentry	Develop prop module. Mission engineering support	Saves one Shuttle mission, discontinues HST engineering support, instruments.	Controlled reentry may exceed risk to ground	Science ends ~ 2007 or when Shuttle mission is manifested
Shuttle installation of prop module in lieu of SM4, continued science	Develop prop module. Mission engineering support	Saves one Shuttle mission, discontinues HST engineering support, instruments.	Final controlled reentry may exceed risk to ground	Science extended if compatible prop module can be developed
SM4, followed by ELV/remote prop module, controlled reentry	Procure ELV, develop prop module, docking technology	Saves one Shuttle mission, HST mission engineering support	Additional time for development of docking technology, installation of “hooks” on SM4	Science out to ~ 2010
SM4, followed by ELV/remote prop module, continued science	Procure ELV, develop prop module, docking technology	Saves one Shuttle mission, HST mission engineering	Additional time for development of docking technology,	Science beyond 2010

		support	installation of "hooks" on SM4	
SM4, followed by Final Shuttle installation of prop module, controlled reentry	Develop prop module, unique mission engineering support for final mission	Same as Baseline	Feasible	Science out to 2010
SM4 followed by Final Shuttle installation of prop module, continued science	Develop prop module, unique mission engineering support for final mission	Same as Baseline	Feasible	Science beyond 2010
SM4, SM5, followed by ELV /remote installation of prop module	Continued HST mission engineering support, Instruments, Procurement of ELV, prop module		Additional time to develop docking systems, prop module	Science beyond 2015

Appendix II

Chronology of Congressional Actions on the Hubble Space Telescope since 1985

This constitutes a summary of the highlights of appropriations reports or bills which specifically mention HST or take a specific action over the past several years. This is not intended to be a comprehensive reflection of the Congressional viewpoint since authorizing bills and floor action typically go into much greater depth.

- FY86—Conference Report "caps" HST budget[6]
- FY87—Conference Report "caps" HST budget
- FY88—House and Senate bills reduce HST by $5 M in order to ensure budgetary discipline in HST while it is awaiting launch prior to resumption of Shuttle flights.
- FY89—Conference Report adds $5 M to HST operations and caps the budget.
- FY90—House bill proposes capping HST, Senate specifically excludes HST from the capped programs.
- FY91—Conference Report adds $30 M to HST budget paving the way to the high water mark in HST funding. This was anticipated to fund the additional work for the corrective optics development and servicing mission.
- FY93—Conference Report reduces overall physics and astronomy by $20M but states "The Conferees agree that funding for the Hubble space telescope should be maintained at the request level."
- FY94—Conference Report adds $22 M for physics and astronomy "with a high priority afforded the Hubble space telescope repair mission." The Senate report states "*The Committee notes..that the failure of the Mars Observer only increases the pressure on NASA to successfully repair and service the Hubble space telescope later this year*." The Senate report also contains the following special discussion of HST: "*The Committee is troubled by opinions expressed by some members of the scientific community that operations of the Hubble space telescope should be terminated 5 years earlier than its planned 15 year on orbit mission. The Committee believes that Hubble should continue to operate so long as it provides useful, credible data for scientific review and analysis. Upon completion of the successful repair of the spacecraft, NASA at an appropriate time, should convene an independent panel, through the National Academy of Sciences, whose members have no personal or institutional stake in the great observatory missions that might follow the HST, to make recommendations about he appropriate length of observation for which NASA should continue support for this mission."*
- FY95—Conference Report increases HST by $10M with specificity for *"the advanced camera instrument*" ($2M), STScI ($3M), and for a reserve account ($5M).

[6] A common practice in that era to restrain budgetary growth.

The Report states *"The Conferees want to make clear that they expect an announcement of opportunity for the advanced camera to be issued shortly, and that it will be part of the 1999 Servicing Mission."* The Senate report further states *"The Committee wishes to make clear that it will not support future reductions in the project's mission operations or data analysis budgets that impede either ongoing science activities or the development of the next generation instruments for the telescopes next two servicing missions."*

- FY00—The Conference Report provides an increase of $23M *"..for science costs related to the next servicing mission of the Hubble Space Telescope. The conferees are aware of the strong support in the scientific community for proceeding with the infrared channel on the Wide Field-3 Camera. The conferees have provided sufficient resources in fiscal year 2000 to begin work on its development so that it will be ready for the final servicing mission now scheduled for Hubble in the 2002-2003 time frame."*

  The House report contains an additional comment on HST: *"Eight flights (of the Shuttle) have been planned for fiscal year 2000, including seven flights for the assembly of the Space Station and one for the repair of the Hubble space telescope. NASA expects to add another shuttle flight to complete repairs and improvements of Hubble during fiscal year 2000. While the Committee supports this additional flight, the Committee remains concerned about the poor planning at NASA HQ for Hubble needs and its cavalier use of Hubble reserves to pay for the cost overruns associated with the Advanced X-Ray Astrophysics Facility."*
- FY01—The House report contains the comment *"The committee continues to note the significant scientific knowledge and discovery which Hubble Space Telescope generates now nearly a decade past its initial launch. The committee believes that HST should continue to have the capabilities to generate significant scientific advancement throughout its currently planned life on orbit. For this reason, the committee believes that additional funds are necessary to cover costs to the program for servicing related expenses caused by delays in launch due to the space shuttle's manifest schedule that have forced the program to deplete critical program reserves. The committee believes that costs should be allocated to the Human Space Flight account absent a reasonable justification fro NASA. As the budget picture becomes clearer, the Committee anticipates providing additional funds to cover these HST costs."* The Conference Report, however, did not accept this cost principle. In addition, the Conference report capped the Wide Field 3 camera.
- FY02—The Conference Report contains the following comment: *"The conferees have provided the budget request of $92 M for advanced technology development related to the Next Generation Space Telescope and expect NASA to vigorously pursue the development of the NGST and submit an out year budget for soliciting development and management proposals with the goal of launch in 2007. If technical and budgetary constraints preclude launch of NGST in 2007, the conferees wish to underscore their strong desire that there should be no gap between the end of operations for HST and the onset of operations for NGST. As part of the out-year*

budget plan, NASA should outline its transition plan to guarantee uninterrupted continuity between HST and NGST."

- FY03—The Conference Report contains the following comment: *"…The conferees commend NASA for the continued success of the Hubble Space Telescope and the extraordinary contributions it has made to the advancement of science. The recent success of the Hubble servicing mission has underscored the continued importance of the Hubble Space Telescope (HST). NASA's plan for HST has been to discontinue servicing missions after 2004 in order to create a funding wedge for the next generation space telescope (NGST), the science community's highest priority, and to return HST to earth in 2010. Due to the loss of Columbia, the conferees are aware that the current schedule for servicing HST has potentially been delayed and that the additional delay could possibly cause degradation of HST earlier than currently anticipated. The current situation may also require additional funding for HST. The conferees direct the program manager to maintain the current schedule for NGST development and not reduce NGST funds to cover HST shortfalls. The conferees direct NASA to carry out an in-depth study of an additional servicing mission and the potential scientific benefits. Further, the conferees direct NASA to study the means for disposing of Hubble following the deployment of the Webb Telescope in the 2010 timeframe. This study should examine the full range of options for disposal of the Hubble including relative costs and mission constraints…."*